ACTA SCIENTIARUM POLONORUM
Acta Sci. Pol. Hortorum Cultus, 22(1) 2023, 3–10
https://czasopisma.up.lublin.pl/index.php/asphc ISSN 1644-0692 e-ISSN 2545-1405 https://doi.org/10.24326/asphc.2023.4117
ORIGINAL PAPER
Accepted: 13.07.2022
Published: 24.02.2023

EFFECT OF FOLIAR SPRAY OF YEAST EXTRACT AND POTASSIUM NITRATE ON YIELD AND FRUIT QUALITY ON *Ziziphus jujuba* L. TREES

Mahmoud Abdel-Aziz Ahmed[1]✉, Abdullah Alebidi[2], Rashid Al-Obeed[2], Alaa Omar[3,4]

[1] Department of Horticultural Crops Technology, National Research Centre, Dokki, Egypt
[2] Plant Production Department, College of Food and Agricultural Science, King Saud University, Saudi Arabia
[3] Horticulture Deptartment, Faculty of Agriculture, Kafresheikh University, Kafr El-Sheikh 33516, Egypt
[4] Institute of Research and Consulting, King Faisal University, Hofuf, Kingdom of Saudi Arabia

ABSTRACT

The present study was conducted during the two successive seasons, 2017 and 2018, at King Saud University, Saudi Arabia, to investigate the effects of foliar sprays on *Ziziphus jujuba* trees by yeast extract at 1% and 2% and potassium nitrate (KNO_3) at 1% and 2%. All treatments were foliar applied twice (December 15 – January 15) in both seasons. Yield and fruit quality were studied. Treatments significantly improved yield, physical fruit and fruit chemical characteristics, moisture content, chlorophyll a, b and total chlorophyll by most tested treatments in both seasons than the control (water only). Yeast spray treatments significantly decreased juice content vitamin C (mg/100 g), while KNO_3 spray treatments increased juice content vitamin C in both seasons. It can be concluded that foliar application with KNO_3 at 2% recorded the best treatment to obtain the highest yield, fruit weight, flesh weight, fruit volume, fruit length and fruit diameter, while yeast extract at 2% treatment gave the highest TSS% and total sugar contents in this study.

Key words: yeast extract, potassium nitrate, yield, fruit quality, *Ziziphus jujuba*

INTRODUCTION

Ber (*Ziziphus* spp.), belongs to the family Rhamnaceae, consisting of 45 genera and 550 species, and is widely distributed in tropical and subtropical climates in the world, i.e., Northern Africa, Southern Europe, and Western Asia [Mukhtar et al. 2004]. Ber fruits are a rich nutritional source of energy, protein, and minerals. It refreshes and restores, improves memory, and remedies high blood pressure [De Bairacli 1991]. Jujube fruits help eliminate oxidative stress in the liver [Shen et al. 2009] and inhibit tumor cells [Fatemeh et al. 2008].

Potassium (K) deficiency is one of the most nutrition management problems under calcareous soil conditions, accounting for leaf chlorosis, scorching, early leaf and fruit abscission, and inferior fruit size and yield [Robbins et al. 1982]. Although K is not a constituent of any functional molecules or plant structures, it is involved in numerous biochemical and physiological processes vital to plant growth, yield, and quality [Marschner 1995]. Adequate K nutrition has been associated with increased yields, fruit size, soluble solids and ascorbic acid concentrations, improved fruit color, increased shelf life, and shipping quality of many horticultural crops [Geraldson 1985, Lester et al. 2005, 2006]. So application of K as a foli-

✉ khider1968@yahoo.com

ar spray has been used to adjust tree K levels in prune [Robbins et al. 1982].

Yeast extract (*Saccharomyces cervisiae*) is a natural component that contains many of the nutrient elements and cytokinins, which is safe and non-pollutant. It has a considerable amount of amino acids [Abou Zaid 1984]; mineral elements, carbohydrates, reducing sugars, enzymes, and vitamins B_1, B_2, B_3, B_{12} [Castelfranco and Beale 1983, Somer 1987, Khedr and Farid 2000]. Also, it is a source of cytokinins and protein that enhance cell division and enlargement [Barnett et al. 1990]. Moreover, Yeo et al. [2000] found that yeast extracts contain trehalose-6-phosphate synthase, a key enzyme for trehalose biosynthesis. Many investigators reported that spraying fruit trees with yeast extract improved growth, yield, and quality, i.e. Abd El-Ghany et al. [2001], Ismaeil et al. [2003] on vines as well as Atawia and El-Desouky [1997], Hegab et al. [2005], Khafagy et al. [2010] found that spraying orange trees with yeast extract were more effective on improving total yield and fruit quality. Also, El-Motty et al. [2010] showed that spraying Keitte mango trees with algae at 2% combined with yeast at 0.2% was very effective increased fruit quality. Mostafa and Abou-Raya [2004] found that, TSS% content was higher values when Grand Nan Banana cv. plant received active dry yeast.

The possibility of using potassium nitrate for improving yield and quality of fruit crops was mentioned by [Southwick et al. 1996] found that potassium nitrate sprays were as effective, or better than soil-applied K in maintaining adequate levels of leaf K throughout the season. Erner et al. [1993], Boman [1997], Boman and Hebb [1998] and Boman [2001] showed that the orange trees sprayed with KNO_3 increased yield and fruit quality compared to the untreated control treatment.

Gill et al. [2012] studied the effect of spraying of 'Patharnakh' pear trees with KNO_3, and found that maximum fruit size was recorded with three sprays of KNO_3 at 1.5 %. Inglese et al. [2002] on olive trees, showed that potassium nitrate sprays at 3% increased fruit yield and fresh fruit weight. Khayyat et al. [2012] showed that potassium nitrate foliar spray on pomegranate increased juice weight and total soluble solids (TSS) compared to the control. Sotiropoulos et al. [2010] showed that foliar application of KNO_3 (3 kg per 1000 kg water) on 'Andross' peach cultivar increased fruit weight. Palsande et al. [2013] studied the effect of foliar application of 2% KNO_3 on cashew nut and found that, the maximum average weight of nut was observed due to the foliar spray of 2% KNO_3. Altındişli et al. [1999], Mosqueda [1989] and Sarker and Rahim [2013] on mango found that yield and quality were influenced by foliar application of potassium nitrate.

The main aim of this study was to investigate the effect of foliar spraying of yeast and potassium nitrate on yield and fruit physio-chemical composition of *Ziziphus jujuba* trees grown under calcareous soil conditions.

MATERIALS AND METHODS

The present study was conducted during the two successive seasons, 2017 and 2018, at the Research and Agricultural Experimental Station, King Saud University, Saudi Arabia. The trees were planted at 4 × 5 m spacing and pruned in April by removing all primary branches leaving 60 cm from the base of the trunk. The harvest date of jujube fruits grown in a calcareous soil under flooding irrigation system. The mechanical and chemical analysis of orchard soil and water irrigation were done, before the experiment had been conducted in the 1st season, as shown in Table 1. Trees were subjected to the same cultural practices usually done in the orchard. In May of both seasons, trees were fertilized with organic manure and calcium superphosphate (15% P_2O_2) at a rate of 20 kg and 1.5 kg per tree, respectively. Also, three kg ammonium sulphate (20.6% N) and 1.5 kg potassium sulphate (48% K_2O) per tree were added in three equal doses at the beginning of May, June, and August.

Fifteen trees were selected as uniform as possible and were subjected to foliar spray during two seasons. All treatments were foliar applied twice (December 15 – January 15) in both seasons. The experiment was designed as a randomised complete block design (RCBD), and the following five foliar spray treatments were applied with three replicates for each treatment: water only (control), yeast extract at 1%, yeast extract at 2%, potassium nitrate (KNO_3) at 1% and potassium nitrate (KNO_3) at 2%.

All treatments were sprayed when the fruitlet was diameter at 3.0–4.0 mm (15–20 days after the fruit set). The surfactant Nourfilm (produced by Alam Chemica)

Table 1. Some physical and chemical characteristics of soil and irrigation water used for the present study

Parameters	Value	Parameters	Soil	Water irrigation
Sand (%)	75.10	pH	–	6.87
Silt (%)	12.00	EC (dS/m)	–	1.68
Clay (%)	12.90	**cations**	**(meq/l)**	**(meq/l)**
Textural class	**sandy loam**	Ca^{2+}	3.30	7.00
Organic matter (%)	0.40	Mg^{2+}	2.50	3.60
pH	7.50	Na^{+}	5.60	9.80
EC (dS/m)	1.00	K^{+}	0.30	0.50
Calcium carbonates (%)	18.79	**anions**	**(meq/l)**	**(meq/l)**
Total N ppm	14	HCO_3	2.60	5.70
P ppm	18.20	$CO_3^{=}$	nd	nd
K ppm	92.00	Cl^{-}	5.00	8.00
–	–	SO_4	3.60	7.30

was added at the rate of 40 cm^3/100 L water (v /v) to all sprayed chemicals to obtain the best penetration results.

Measurements and determination

Yield. In both seasons, fruits from each tree (replicate) were harvested when the fruit color turned to light green (ovary green). All the harvested fruits were weighed to record the total yield (kg/tree) at harvest date.

Fruit physical characteristics. A sample of 3 kg fruits for each replicate was randomly collected in both seasons, and the following fruit characteristics were determined; fruit weight (g), flesh weight (g), seed weight (g), fruit volume (cm^3), fruit length and diameter (cm), fruit shape index (fruit length/ diameter) and fruit firmness was recorded by using Fruit Hardness Tester (No. 510-1) as a small cylinder (5 mm in diameter).

Fruit chemical characteristics. At maturity stage, a representative sample of 2 kg fruits were taken from each tree (replicate) in both seasons, and the following characteristics were determined: total soluble solids by using a hand refractometer, total acidity (%), fruit pH by using pH meter, sugar content (reducing, non-reducing and total sugar), ascorbic acid content (mg/100 ml juice), moisture content, were determined according to AOAC [2000].

Pigments (chlorophyll a, b, and total chlorophyll). Fresh mature fruit samples from the skin (0.03 gm) were extracted with 5ml N dimethylformamide, then chlorophyll a, b, and total chlorophyll were determined colorimetrically at the wavelength of 663.8 and 646.8 nm, respectively, then concentrations of each component was calculated by Porra et al. [1989] as follows:

$$\text{Chlorophyll a} = \\ = 13.43 \times A\,663.8 - 3.47 \times A\,646.8 \quad (\text{nm/ml})$$

$$\text{Chlorophyll b} = \\ = 22.9 \times A\,646.8 - 5.38 \times A\,663.8 \quad (\text{nm/ml})$$

$$\text{Total chlorophyll} = \\ = 19.43 \times A\,646.8 + 8.05 \times A\,663.8 \quad (\text{nm/ml})$$

Statistical analysis. Data obtained throughout this study were statistically analyzed using the analysis of variance method as reported by Snedecor and Cochran [1980]. The least significant difference (LSD) at 5% was used to compare between means.

RESULTS

Yield (kg tree^{-1}). Results revealed that the highest yield (94.00 and 82.93 kg tree^{-1}) in the first and second

season, respectively, were obtained in KNO_3 at 2% foliar spray, whereas, the lowest yield (52.00 and 56.50 kg tree^{-1}) were recorded in control (spray with water only) (Tab. 2). In this respect, data are shown in Table 2 increased yield by all tested treatments in 2017 and 2018 seasons than the control (water only).

length and fruit diameter increased with increasing the concentrations of yeast extract or KNO_3 in both studied seasons. Data presented in Table 2 showed that the average seed weight and fruit shape index was not significantly affected by any of the experimental treatments in both seasons. Concerning the fruit firmness,

Table 2. Yield and physical fruit characteristics of *Ziziphus jujuba* as affected by foliar spray of yeast extract and potassium nitrate during 2017 and 2018 seasons

Treatments	Yield (kg tree^{-1})	Fruit weight (g)	Flesh weight (g)	Seed weight (g)	Fruit volume (cm^3)	Fruit length (cm)	Fruit diameter (cm)	Fruit shape index	Firmness kg/cm^2
2017 season									
Control	52.00e	19.86e	18.10e	1.76a	21.00e	3.97c	3.30d	1.20a	8.33b
Yeast 1%	64.67d	23.97d	22.35d	1.62a	24.33d	4.17bc	3.53c	1.18a	7.78c
Yeast 2%	72.33c	26.77c	25.12c	1.65a	28.67c	4.10c	3.35d	1.22a	6.56d
KNO_3 1%	81.00b	30.30b	28.67b	1.63a	31.00b	4.40b	3.83b	1.15a	9.16a
KNO_3 2%	94.00a	39.37a	37.56a	1.81a	41.33a	4.70a	4.10a	1.15a	8.24bc
2018 season									
Control	56.50d	19.05e	17.44e	1.61a	20.67c	3.88c	3.15b	1.23a	8.47b
Yeast 1%	62.83c	20.57d	18.80d	1.77a	22.00c	4.08b	3.19b	1.28a	7.58c
Yeast 2%	65.17c	22.77c	20.96c	1.81a	24.33b	4.07bc	3.28b	1.24a	6.80d
KNO_3 1%	74.77b	31.01b	29.28b	1.73a	33.67a	4.53a	3.77a	1.20a	9.54a
KNO_3 2%	82.93a	33.16a	31.42a	1.74a	35.33a	4.60a	3.80a	1.21a	8.22bc

Means within each column with the same letter are not significantly different at 5% level

Fruit physical characteristics. The effect of yeast extract and potassium nitrate treatments on physical fruit characteristics at harvest date is presented in Table 2. Regardless of the control, a significant increase in fruit weight, flesh weight, fruit volume, fruit length, and fruit diameter was obtained by all sprayed (yeast extract or KNO_3 at 1% and 2%) compared to the control. Maximum values in fruit weight, flesh weight, fruit volume, fruit length, and fruit diameter were found when sprayed with KNO_3 at 2%, followed by KNO_3 at 1% in the two studied seasons. In this respect, yeast extract at 1% or 2% increased in fruit weight, flesh weight, fruit volume, fruit length, and fruit diameter compared to the control (water only) in both studied seasons. It is clear from Table 2 that in studied seasons; fruit weight, flesh weight, fruit volume, fruit the data obtained in Table 2 indicated that the KNO_3 at 1% treatment gave the highest fruit firmness in the first and second seasons; however, the yeast extract at 2% treatment gave the lowest values. In this respect, foliar sprayed yeast extract at 1% or 2% decreased fruit firmness compared to the foliar sprayed KNO_3 or control treatments.

Fruit chemical characteristics. Data in Tables 3 and 4 showed the effect of foliar spray of yeast extract and potassium nitrate on fruit chemical characteristics of jujuba in the two seasons. The present data clearly indicated that foliar spray of yeast extract at 2% significantly increased the TSS (%), non- reducing sugars and total sugars (%) contents than other treatments and control. This was obtained in both seasons of study. Reducing sugars (%) content was not significant-

Table 3. Fruit chemical characteristics of *Ziziphus jujuba* as affected by foliar spray of yeast extract and potassium nitrate during 2017 and 2018 seasons

Treatment	TSS (%)	Acidity (%)	PH	Reducing sugars (%)	Non-reducing sugars (%)	Total sugars (%)
2017 season						
Control	13.40d	0.55a	4.35c	8.46a	2.98c	11.44c
Yeast 1%	16.73a	0.41cd	4.63b	8.49a	4.80ab	13.29a
Yeast 2%	17.27a	0.37d	4.75a	8.50a	5.28a	13.79a
KNO_3 1%	14.93c	0.47b	4.42c	8.73a	3.75bc	12.48b
KNO_3 2%	15.93b	0.44bc	4.55b	9.03a	3.62c	12.65b
2018 season						
Control	12.53d	0.64a	4.24c	5.88a	4.31d	10.20d
Yeast 1%	14.27b	0.48c	4.58b	5.67a	7.26ab	12.93b
Yeast 2%	15.40a	0.43d	4.97a	6.02a	7.58a	13.60a
KNO_3 1%	13.40c	0.53b	4.39bc	5.96a	5.45c	11.41c
KNO_3 2%	13.87bc	0.54b	4.43bc	5.90a	6.71b	12.61b

Means within each column with the same letter are not significantly different at 5% level

Table 4. Fruit chemical characteristics of *Ziziphus jujuba* as affected by foliar spray of yeast extract and potassium nitrate during 2017 and 2018 seasons

Treatments	Vitamin C mg/100 ml juice	Moisture content (%)	Chlorophyll a (nm/ml)	Chlorophyll b (nm/ml)	Total chlorophyll (nm/ml)
2017 season					
Control	49.07_C	76.50c	2.55a	0.51a	3.06a
Yeast 1%	42.50d	78.62b	1.17c	0.32a	1.49c
Yeast 2%	38.27d	78.73b	0.61d	0.24a	0.85d
KNO_3 1%	56.00b	81.30a	2.06b	0.47a	2.50b
KNO_3 2%	61.20a	81.53a	2.11b	0.43a	2.55b
2018 season					
Control	50.57c	78.02d	3.37a	0.57a	3.94a
Yeast 1%	42.93d	79.09c	1.76c	0.54a	2.30c
Yeast 2%	35.27e	79.58bc	1.20d	0.57a	1.77d
KNO_3 1%	54.93b	80.40b	2.03c	0.48a	2.51bc
KNO_3 2%	59.40a	82.35a	2.55b	0.42a	2.97b

Means within each column with the same letter are not significantly different at 5% level

ly affected by any of the experimental treatments in both seasons. Fruit acidity as percentage decreased by spraying yeast extract and potassium nitrate treatments compared to the control in both seasons. Fruit PH increased by yeast extract spraying treatments compared to control in both studied seasons 2017 and 2018. The highest values in fruit PH were found when sprayed with yeast extract at 2% in jujuba fruit in both seasons. Data in Table 4 indicated that fruit vitamin C (ascorbic acid) content was higher when jujuba trees were

treated with foliar spray of KNO_3 at 2% compared to other treatments and control in both studied seasons. As for the moisture content percentage, results in Table 4 showed that moisture fruit content was significantly affected by the different treatments. Trees treated by foliar spray of KNO_3 at 2% treatment increased moisture content in fruits, on the other hand, control trees gave the lowest moisture fruit content during this study. Data depicted in Table 4 indicate that pigments (chlorophyll a and total) in peel fruits were increased from control trees. At the same time, the lowest value was obtained from trees treated by foliar spray of yeast extract at 2% treatment, during this study. Chlorophyll b content in peel fruits was not significantly affected by any experimental treatments in both seasons.

DISCUSSION

Our results showed that yeast extract and potassium nitrate were improved yield, fruit physical and chemical characteristics in both seasons than the control (water only). These results agree with those obtained by Boman [2001], who found that KNO_3 sprays increased the number of fruits per tree, fruit yield compared to the untreated control treatment. Generally, the essential element potassium has a significant regulatory role within plant cells and organs, such as activating more than 50 enzymes, osmosis regulation and photosynthesis, and loading and unloading of sugars in phloem [Mengel 2007]. Also, Inglese et al. [2002] on olive trees, showed that potassium nitrate sprays at 3% increased fruit yield. These results are in line also with those reported by Hegab et al. [2005], Atawia and El-Desouky [1997] and El-Motty et al. [2010] showed that spraying yeast improving yield as a number of fruits or weight [kg tree^{-1}]. In general, these findings concerning the response of *Ziziphus jujuba* fruit physical properties to a foliar spray of yeast extract and potassium nitrate go in line with those found by Khafagy et al. [2010], Hegab et al. [2005], Atawia and El-Desouky [1997] and El-Motty et al. [2010] they foliar spray of yeast extract on fruit trees, and found that increasing in weight, length and volume. These results are in agreement with those reported by Boman [1997], Boman and Hebb [1998], Boman [2001], Gill et al. [2012], Inglese et al. [2002], Sotiropoulos et al. [2010] they showed that the fruits sprayed with KNO_3 improved the average physical characteristics such as fruit weight, fresh weight, fruit volume and fruit dimension. These results are in line with those reported by Abd El-Ghany et al. [2001] and Ismaeil et al. [2003] on vines as well as by Atawia and El-Desouky [1997], Boman [1997], Boman and Hebb [1998], Boman [2001] and Khafagy et al. [2010] on orange, El-Motty et al. [2010] on mango, Mostafa and Abou-Raya [2004] on banana fruit, Gill et al. [2012] and Khayyat et al. [2012] on pomegranate, they found that foliar spray of yeast extract and potassium nitrate was more effective in increasing total soluble solids, total, reducing and non-reducing sugars percentage ascorbic acid and decreasing fruit acidity.

CONCLUSIONS

The results of the present investigation indicated that foliar application of dry yeast extract at 1% and 2% and Potassium Nitrate (KNO_3) at 1% and 2% on *Ziziphus jujuba* trees were improved yield, fruit physical and chemical characteristics. Yeast spray treatments decreased vitamin C (mg/100 g) juice content, while KNO_3 spray treatments increased vitamin C in both seasons. Foliar application with KNO_3 at 2% recorded the best treatment to obtain the highest yield and physical characteristics, while yeast extract at 2% treatment gave the highest TSS% and total sugar contents.

ACKNOWLEDGMENTS

With sincere respect and gratitude, we express our deep thanks to the Deanship of Scientific Research, King Saud University and the Agriculture Research Center, College of Food and Agricultural Sciences for financial support, sponsorship, and encouragement.

REFERENCES

Abd El-Ghany, A.A., El-Said, A.S., Said, B.A., Marwad, I.A. (2001). The effect of two yeast extract strains or their extraction on vines growth and cluster quality of Thompson Seedless. Assiut J. Agric. Sci., 32(1), 215–224.

Abou Zaid, M. (1984). Biochemical studies on fodder yeast. Ph. D. Thesis Fac. Agric. Cairo Univ. Egypt.

Altındişli, A., İrget, M.E., Kalkan, H., Kara, S., Oktay, M. (1999). Effect of foliar applied KNO_3 on yield, quality

and leaf nutrients of Carignane and Colombard wine grapes. Springer Netherlands – Improved Crop Quality by Nutrient Management, 103–106.

AOAC. (2000). Official methods of Analysis. Association of Official Agricultural Chemists, Washington, D.C.

Atawia, A.A.R., El-Desouky, S.A. (1997). Trials for improving fruit set, yield and fruit quality of Washington navel orange by application of some growth regulators and yeast extract as a natural source of phytohormones. Ann. Agric. Sci. Moshtohor, 35(3), 1613–1632.

Barnett, J.A., Payne, R.W., Yarrow, D. (1990). Yeasts characteristics and identification. Cambridge University Press, pp. 999.

Boman, B. (1997). Effectiveness of fall potassium sprays on enhancing grapefruit size. Proc. Fla. State Hort. Soc., 110, 1–7.

Boman, B.J., Hebb, J.W. (1998). Post bloom and summer foliar K effects on grapefruit size. Proc. Fla. State Hort. Soc., 111, 128–134.

Boman, B.J.(2001). Foliar nutrient sprays influence yield and size of 'Valencia' orange. Proc. Fla. State Hort. Soc., 114, 83–88.

Castelfranco, P.A., Beale, S.I. (1983). Chlorophyll biosynthesis recent advances and areas of current interest. Ann. Rev. Plant Physoil., 34, 241–278.

De Bairacli, L.J. (1991). The illustrated herbal handbook for everyone. Faber and Faber, London.

El-Motty, E.Z.A., Shahin, M.F.M., El-Shiekh, M.H., Abd-El-Migeed, M.M.M. (2010). Effect of algae extract and yeast application on growth, nutritional status, yield and fruit quality of Keitte mango trees. Agric. Biol. J. N. Am., 1(3), 421–429.

Erner, Y., Kaplan, Y., Artzi, B., Hamou, M. (1993). Increasing citrus fruit size using Auxins and potassium. Acta Hortic., 329, 112–119. https://doi.org/10.17660/ActaHortic.1993.329.20

Fatemeh, V., Mohsen, F.N., Kazem, B. (2008). Evaluation of inhibitory effect and apoptosis induction of *Zizyphus jujube* on tumor cell lines, an in vitro preliminary study. Cytotechnology, 56(2), 105–111. https://doi.org/10.1007/s10616-008-9131-6

Geraldson, C.M. (1985). Potassium nutrition of vegetable crops. In: Potassium in agriculture, R.D. Munson (ed.). ASA-CSSA-SSSA, Madison, WI, pp. 915–927.

Gill, P.P.S., Ganaie, M.Y., Dhillon, W.S., Singh, N.P. (2012). Effect of foliar sprays of potassium on fruit size and quality of 'Patharnakh' pear. Ind. J. Hortic., 69(4), 512–516.

Hegab, M.Y., Sharawy, A.M.A., El-Saida, S.A.G. (2005). Effect of Algae extract and mono potassium phosphate on growth and fruiting of Balady orange trees (*Citrus sinensis*). Proc. First Sci. Conf. Agric. Sci. Fac. Agric., Assuit Univ., 1, 73–84.

Inglese, P., Gullo, G., Pace, L.S. (2002). Fruit growth and olive oil quality in relation to foliar nutrition and time of application. Acta Hort. (ISHS) 586, 507–509. https://doi.org/10.17660/ActaHortic.2002.586.105

Ismaeil, F.H.M., Wahdan M.T., El-Sheikh, A.F. (2003). Response of Thompson seedless and Roumi 3 Red grape cultivars to foliar sprays with yeast extract and GA_3. J. Agric. Sci., Mansoura Univ., 28(8), 6321.

Khafagy, S.A.A., Zaied, N.S., Nageib, M.M., Saleh, M.A., Fouad, A.A. (2010). The beneficial effects of yeast and zinc sulphate on yield and fruit quality of Navel orange trees. World J. Agric. Sci., 6(6), 635–638. http://www.idosi.org/wjas/wjas6(6)/1.pdf

Khayyat, M., Tehranifar, A., Zaree, M., Karimian, Z., Aminifard, M.H., Vazifeshenas, M.R., Amini, S., Noori, Y., Shakeri, M. (2012). Effects of potassium nitrate spraying on fruit characteristics of 'Malas Yazdi' pomegranate. J. Plant Nutr., 35(9), 1387–1393. https://doi.org/10.1080/01904167.2012.684130

Khedr, Z.M., Farid, S. (2000). Response of naturally virus infected plants to yeast extract and phosphoric acid application. Ann. Sci. Moshtohor, Egypt, 38, 927–939.

Lester, G.E., Jifon, J.L., Makus, D.J. (2006). Supplemental foliar potassium applications with and without surfactant can enhance netted muskmelon quality. HortScience 41(3), 741–744.

Lester, G.E., Jifon, J.L., Rogers, G. (2005). Supplemental foliar potassium applications during muskmelon (*Cucumis melo* L.) fruit development can improve fruit quality, ascorbic acid and beta-carotene contents. J. Am. Soc. Hort. Sci. 130, 649–653. https://doi.org/10.21273/JASHS.130.4.649

Marschner, H. (1995). Functions of mineral nutrients: macronutirents. In: Mineral nutrition of higher plants, Marschner H. (ed.). Academic Press, New York, p. 299–312.

Mengel, S. (2007). Potassium. In: Handbook of plant nutrition, Barker, A.V., Pilbean, D.J. (eds.). CRC Taylor and Francis, New York, USA, pp. 395–402.

Mosqueda, V.R. (1989). Inducción y diferenciación floral en frutales tropicales y subtropicales. Una especie de revisión. En Producción forzada en frutales. Colegio de Postgraduados. Chapingo, México, 38 pp.

Mostafa, E.A.M., Abou-Raya, M.S. (2004). Effect of soil application of active dry yeast on growth, yield and fruit quality of Grand Nan Banana cv. Arab Univ. J. Agric. Sci., Ain Shams Univ., Cairo, 12(2), 693–704.

Mukhtar, H.M., Ansari, S.H., Ali, M., Naved, T. (2004). New compounds from *Zizyphus vulgaris*. Pharmaceut. Biol., 42(7), 508–511. https://doi.org/10.3109/13880200490891890

Palsande, V.N., Dabke, D.J., Kasture, M.C., Khobragade, N.H., Patil, S.D. (2013). Effect of urea, potassi-

um nitrate and insecticides through foliar application on growth, yield and quality of cashewnut. BIOINFOLET Quart. J. Life Sci., 10, 347–349.

Porra, R.J., Thompson, W.A., Kriedemann, P.E. (1989). Determination of accurate extinction coefficients and simultaneous equations for assaying chlorophylls a and b extracted with four different solvents: verification of the concentration of chlorophyll standards by atomic absorption spectroscopy. Biochim. Biophys. Acta, 975, 384–394.

Robbins, S., Chaplin, M.H., Dixon, A.R. (1982). The effect of potassium soil amendments, trenching and foliar sprays on the mineral content, growth, yield and fruit quality of sweet cherry (*Prunus avium* L.) and prune (*Prunus domestica* L.). Commun. Soil Sci. Plant Anal., 13, 545–560.

Sarker, B.C., Rahim, M.A.) 2013). Remove from marked Records Yield and quality of mango (*Mangifera indica* L.) as influenced by foliar application of potassium nitrate and urea. Bangladesh J. Agric. Res., 38(1), 145–154.

Shen, X., Tang, Y., Yang, R., Yu, L., Fang, T., Duan, J.-A. (2009). The protective effect of *Zizyphus jujube* fruit on carbon tetrachloride-induced hepatic injury in mice by anti-oxidative activities. J. Ethnopharmacol., 122(3), 555–560. https://doi.org/10.1016/j.jep.2009.01.027

Snedecor, G.W., Cochran, W.G. (1980). Statistical methods. 6th ed. Oxford, J.B.H. Pub. Bombay, New Delhi.

Somer, R. (1987). Yeast production. Hefeautolysate-Herstellung, Eigenschaften und Anwendungen. BDLSpktrum 3, Bund Deutscher Lebens mittel ev. Rhenania Fachveriag, Hamburg.

Sotiropoulos, T., Therios, I., Voulgarakis, N. (2010). Effect of various foliar sprays on some fruit quality attributes and leaf nutritional status of the peach cultivar 'Andross'. J. Plant Nutr., 33(4), 471–484. https://doi.org/10.1080/01904160903506225

Southwick, S.M., Olson, W., Yeager, J., Weis, K.G. (1996). Optimum timing of potassium nitrate spray applications to 'French' prune trees. J. Amer. Soc. Hort. Sci., 121(2), 326–333.

Yeo, E.T., Kwon, H.B., Han, S.E., Lee, J.T., Ryu, J.C., Byun, M.O. (2000). Genetic engineering of drought resistant potato plants by introduction of the trehalose-6-phosphate synthase (TPSI) gene from Saccharomyces cerevisiae. Mol. Cells., 10(3), 263–268.